Proceedings of Coastal Zone 07
Portland, Oregon
July 22 to 26, 2007

Using Historical Narrative to Analyze Economic Indicators of Marine and Coastal Management

Linwood Pendleton, UCLA

Keywords: economic indicator, integrated, analysis, coastal management

The public debate concerning the social and economic impacts of coastal management decisions often is based more on anecdote than science. One reason for this phenomenon is because as scientists we have failed generally to show that changes in the coastal environment (i.e changes that fall within the realm of past experience) have an impact on locally important economic activities. Further, while we have developed a number of indicators to monitor ecosystem health (e.g. fecal bacteria indicators, nutrient loads, dissolved oxygen), we know little about how measurable changes in environmental quality are linked to measurable changes in economic activity at the local level. As a result we are generally unable to show that coastal policies have yielded measurable improvements in the way people use, enjoy, and benefit economically from these ecosystems.

In most cases, the public and even coastal policy professionals are unaware of the economic contributions of environmentally-dependent coastal activities. Economic data are rarely collected at a level that corresponds well with the spatial extent of a marine ecosystem whether that ecosystem is a large marine ecosystem, a major estuary (e.g. San Francisco Bay) or a smaller embayment like California's Morro Bay. As a result, it is difficult for planners to put the costs of restoration and management in the context of the economic activities that might benefit from such policies. Making the matter even more complicated is the fact that restoration and foregone development often represent large one-time values, while the economic value of environmentally robust coastal ecosystems usually are in the form of smaller values distributed over long periods of time. Without a good understanding of the annual, and potentially sustainable, values of ecosystem-dependent economic activities, the costs of management and the foregone cost of coastal development often seem disproportionately large.

COASTAL ENVIRONMENTAL CONDITIONS AND ECONOMIC ACTIVITY

There is little empirical evidence to show how environmental change has affected local marine-based economies and even less evidence we can use to predict how coastal management will affect local economic activity. In the late 1980s, a number of studies demonstrated the economic impacts on fisheries of large scale losses of mangroves and wetlands (Lynne et al. 1981; Kahn and Kemp 1985; Ellis and Fisher 1987). Similarly, a whole literature of bio-economic studies have attempted to link environmental conditions to fisheries output, but the measures of environmental quality are often not available or appropriate at the scale of most coastal management decisions (see Knowler 2002 for a review). Further, the empirical studies that do exist tend to be static. As a result we can only *predict* the economic impact of changes in ecosystems based on spatially differences in environmental quality and economic activity (Knowler, 2002, finds only one such fisheries study based on the anchovy fishery in the Black Sea). Examples of empirical

evidence that ecosystem change affects non-extractive economic activities is even harder to find in the literature.

A FRAMEWORK FOR LINKING ECOSYSTEMS AND ECONOMICS

An important challenge for those involved in coastal policy is to show that management and restoration activities are accomplishing their intended goals. Coastal management scholars and professionals use variations on a basic model known as the Pressure-State-Impact model to understand, and even account for, the links between people and activities (see OECD 1994, Winograd et al. 1998, Segnestam 2002, and Bowen and Riley 2002 for good reviews of the model). At its core, the model provides a conceptual accounting that links the pressures of human population growth and development (PRESSURE) to changes in the state of the marine environment (STATE) to changes in human activities and human values derived from marine goods and services (IMPACTS). For instance, human wastewater (PRESSURE) may change bacterial levels in an estuary (STATE) which in turn adversely impacts swimming and causes gastrointestinal illnesses among swimmers (IMPACTS).

Beyond providing a conceptual framework for understanding the way people and the environment interact, the PSI core framework also serves as a guide for collecting data to model and predict how changes in human behavior affect the environment and how these environmental changes in turn affect humans and their behavior. Towards that end, great progress has been made in collecting data to characterize and monitor change in the STATE of the ecosystem. Environmental indicators are used to measure levels of nutrients, bacterial contamination, turbidity, salinity, and a host of other dimensions that help to characterize ecosystems. Far less effort, however, has been invested in developing measures of human response and activity.

Recognizing the need to measure and monitor both the environmental and socio-economic outcomes of coastal management, a number of scholars and organizations have embarked on attempts to design and collect data on integrated ecological and socio-economic indicators of ecosystem health. The OECD, European Union, and Environment Canada all have developed frameworks for the collection of integrated coastal and marine indicators (see Bowen and Riley, 2003, for a brief review). More recently, NOAA Coastal Restoration Center has developed a framework for measuring the human dimensions of coastal restoration (Salz and Loomis 2005).

One goal of indicator development is to identify data that can be easily and accurately collected over time. According to the OECD (1988) a good indicator should reduce the number of measures which normally would be required for an exact presentation of a situation. Further, indicators should simplify the process of communication to managers, stakeholders and communities. Bowen and Riley (2003) go even further writing that "indicators should represent dynamic parts of an overall portrait that is understandable and compelling to its intended user community." A number of other authors have developed frameworks for integrated indicators, many of which are developed for fisheries (see for example Cairns et al. 1993 and Ward, 2000, for general frameworks and Bonzon, 2000,Christensen, 2000, Hundloe, 2000 for fisheries based frameworks.) Salz

and Loomis provide a good discussion of socio-economic indicators, in the context of ecological indicators (but not directly integrated).

Developing A Baseline of Economic Activity

Initially, the list of candidate economic activities will be a long one, reflecting the business interests of many stakeholders. Many waterfront businesses and activities, however, are not directly dependent upon environmental conditions (e.g. curio and saltwater taffy shops). In our research, we work with stakeholders to pare the list of candidate indicators by asking a simple question "how does each activity depend on the ecological condition of the bay?" To make the question even more direct, we turn it on its head and start with the list of environmental goods and services. For each environmental good and service, we asked "what economic activity might change if this ecological good or service changed." By taking this approach, we created a shorter list of economic activities (See Table 1 for an example of economic indicators).

To properly understand the economic consequences of ecosystem change, we need economic indicator data that ideally reflects both the output and value of activities. Output measures for economic activities fall into two basic categories: measures of physical output (e.g. landings of fish, volume of sediments removed) and measures of human activity (e.g. recreational visit days, park attendance). Value measurements also fall into two categories: measures of economic impact (usually measured as gross revenues or expenditures) and estimates of economic value (usually measured as consumer and producer surplus or the willingness of the user to pay to participate in an activity beyond the costs of participation). Except for commercial fishing data, for which state and federal agencies report gross revenues for landed catch, the collection of on-site data about gross revenues and consumer surplus data is too difficult for such data to be considered as indicators. The problem is twofold. First, private firms are reluctant to reveal gross revenue data. Second, original studies to estimate consumer and producer surplus values are costly and difficult to apply on a repeated time series regime. Because of the difficulty of collecting economic impact and value data, we focus on measures of output for our economic indicators, but we use estimates of economic impact and value from the literature to places individual indicators in an economic context that helps us to weigh the relative economic importance of changes in specific indicators.

Analyzing Economic Indicator Data

While many frameworks have been developed for integrated coastal indicators, there is relatively little guidance about how to analyze these data. Specifically, guidance is lacking on how to demonstrate that changes in ecosystem health, especially changes linked to policy, affect socio-economic outcomes. Salz and Loomis (2005) warn of the difficulty of determining causality based on economic indicators. Often it is suggested that analysts find control areas to determine if changes in socio-economic indicators are the result of coastal management, marine protection, or coastal restoration. Unfortunately, it often is impossible to find true controls for estuaries, coastal regions, or other areas that are the focus of coastal management. Further, simple control comparisons suffer from limited statistical power. Bowen and Riley (2003) write that "an

ideal combination of indicators could be fed into a conceptual or technical model that efficiently identifies what, where, how, and why change is occurring, "but more sophisticated statistical methods are required to fully analyze integrated coastal indicator data (Bowen and Reilly). Unfortunately, the authors do not provide explicit guidance for what these methods might be.

While multivariate analysis is required to fully analyze the effect of environmental conditions on economic activity, historical narrative also can be used to gain a better understanding of the relationship between ecosystem indicators and economic indicators. We use historical data from three California coastal areas to understand the ways environmental and economic indicators can be analyzed. To use historical narrative we follow a three stop process of examination and deduction. First, we plot historical data to examine trends in economic indicators and identify major changes in economic activities. Second we work with local stakeholders to determine if regulation, access, weather events or other factors may explain changes in the economic indicator. Third, we examine historical patterns in ecosystem indicators to determine whether changes in ecosystem conditions may have lead to changes in economic activity.

Table 1: Sample Economic Activities and Candidate Indicators

Ecosystem Good or Service	***Economic Activities***	***Economic Indicator***
Fish	Commercial Fishing	Landings (by species), value (by species)
Fish	Commercial Passenger Fishing Vessels (CPFV)	Passenger trips, Landings (by species)
Fish	Marine Ice Sales	Tons, Gross sales
Fish	Recreational Fishing	Trips
Water Quality	Oyster Production	Pounds, gross value
Water Quality Wildlife	Kayaking	Charters, Trips, Revenues
Water Quality Wildlife	Park Attendance	Attendance days
Water Quality	Beach Attendance	Attendance days
Wildlife	Hunting	Activity Days
Water Quality Wildlife	Tourism	Hotel Occupancy
Sediments	Boating/Navigation	Volume of Sediments Removed, Dredging Costs
Sediments	Electric Power Plant Cooling	Maintenance Costs for cooling intake systems

References:

Bonzon, A. (2000). "Development of economic and social indicators for the management of Mediterranean fisheries." Marine and Freshwater Research **51**(5): 493-500.

Bowen, R. E. and C. Riley (2003). "Socio-economic indicators and integrated coastal management." Ocean & Coastal Management **46**: 299-312.

Cairns, J., P. V. McCormick, et al. (1993). "A proposed framework for developing indicators of ecosystem health." Hydrobiologia **263**: 1-44.

Christensen, V. (2000). "Indicators for marine ecosystems affected by fisheries." Marine and Freshwater Research **51**(5): 447-450.

Ellis, Gregory M., and Anthony C. Fisher. 1987. Valuing the environment as input. *Journal of Environmental Management* 25: 149-156.Hundloe, T. J. (2000). "Economic performance indicators for fisheries." Marine and Freshwater Research **51**(5): 485-491.

Kahn, J. R., and W. M. Kemp. 1985. Economic losses associated with the decline of an ecosystem: The case of submerged aquatic vegetation in the Chesapeake Bay. *Journal of Environmental Economics and Management* 12: 246-263.

Knowler, D. (2002). "A review of selected bioeconomic models with environmental influences in fisheries." Journal of Bioeconomics **4**: 163-181.

Lynne, Gary D., Patricia Conroy, and Frederick J. Prochaska. 1981. Economic valuation of marsh areas for marine production processes. *Journal of Environmental Economics and Management* 8: 175-186.

Salz, R. and D. Loomis. 2005. The Human Dimensions of Coastal Restoration. In Science-Based Restoration Monitoring Of Coastal Habitats: Volume Two, Chapter 14.

Segnestam, L. 2002. Indicators of Environment and Sustainable Development. Paper No. 89. World Bank. Environmental Economic Series.

(Organization for Economic Cooperation and Development (OECD). Towards sustainable development: environmental indicators. Paris, 1998.

Ward, T. J. (2000). "Indicators for assessing the sustainability of Australia's marine ecosystems." Marine and Freshwater Research **51**(5): 435-446.

Winograd, M., Fernandez, N.F., and Farrow, A. 1998. Tools for Making Decisions in Latin America and the Caribbean. CIAT: Cali, Colombia; UNEP: Mexico City, Mexico.

Linwood Pendleton,
Dept. of Environmental Health Sciences,
University of California, CHS 46-070A,
Los Angeles, CA 90095-1772